Virtual Workshop on Combined Cycle Modeling ****REVISION #2****

June 24th, 2005

Agenda

- Overview of the Combined Cycle Model
- Modeling Combined Cycle Units
- Next Steps
- eMKT Overview

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Overview

- First Functioning Model used in the Industry
- Evolving technology
- With the existing model, combined cycle plants must be modeled as composite units
- Existing model creates many problems for participants since these plants have many operational constraints that cannot be captured using the composite representation

Issues

- Restricted operating ranges for each configuration
- Minimum up and down time requirements for individual components
- Correct representation of start up cost for each component
- Ramping constraints that may be dependant on individual component limits

Features

- Each Physical component of the plant is modeled and has all the normal unit constraints
- Each Combustion turbine and each Steam turbine can have its own startup cost, minimum up/down time, cost curves etc.
- Optional field that enforces a minimum time between startups for all the CTs in the plant
- The Steam output is a function of the CT output
- There is a field to indicate if unit should be modeled as simple cycle.
- The Steam Unit can only be committed if at least one CT is committed

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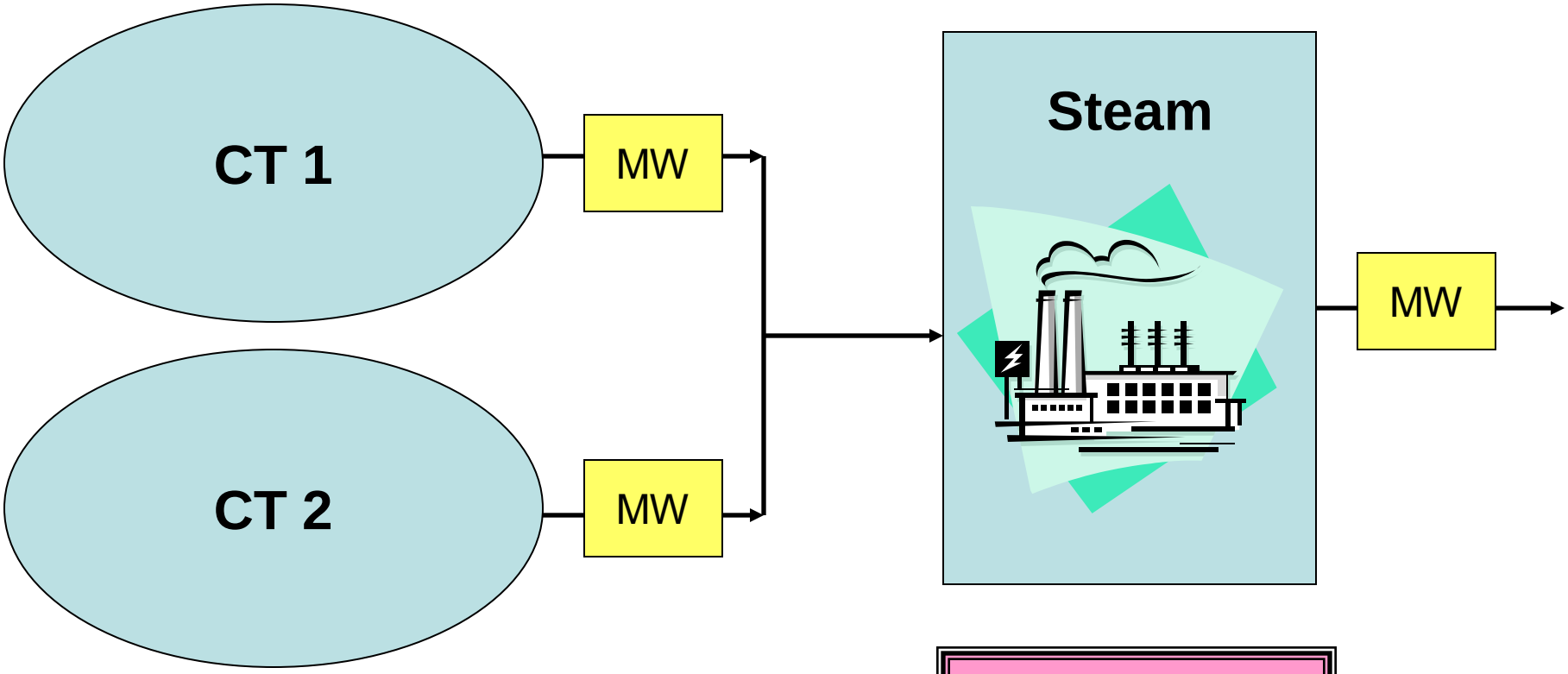
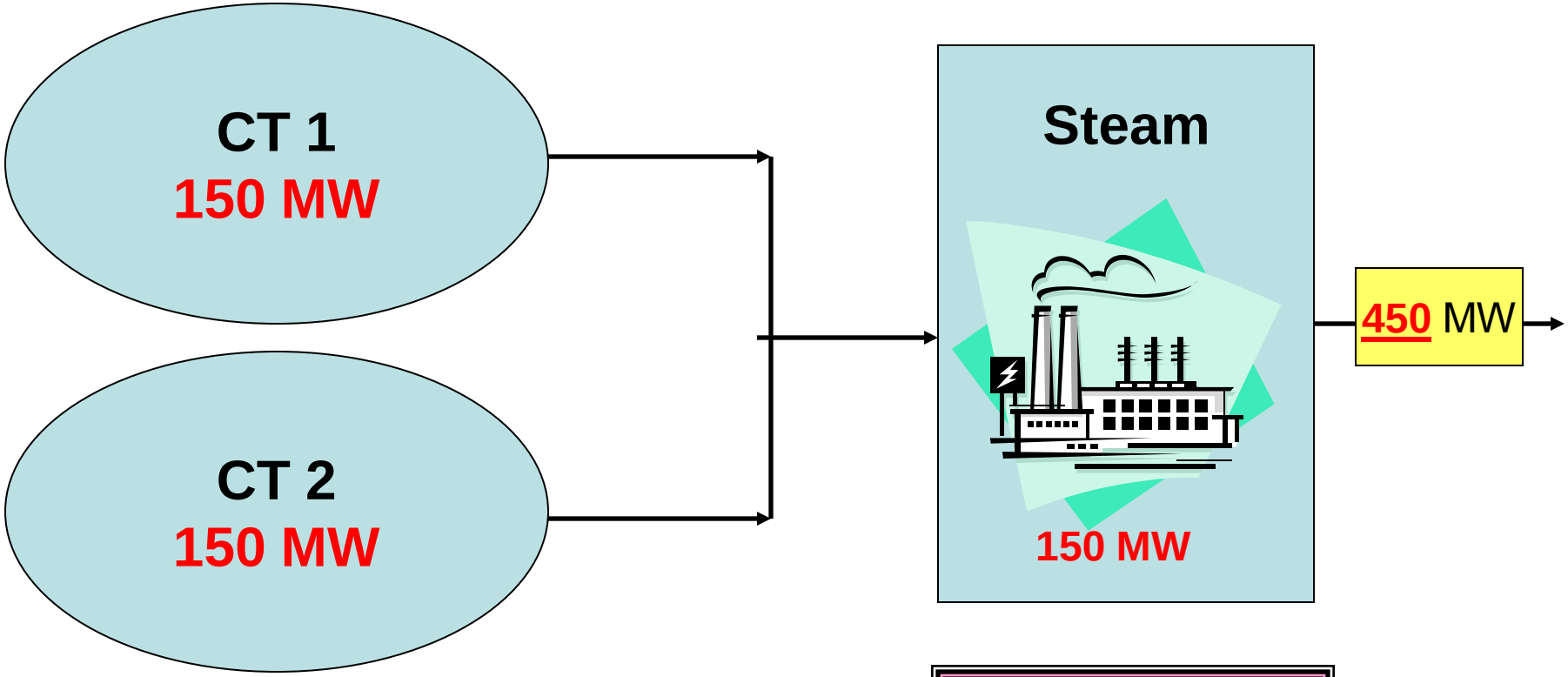
Modeling Combined Cycles



One Factor per Plant

Modeling Combined Cycles - Example



One Factor per Plant = .50

Production Cost Example - Input

Data Elements	CT 1		CT 2		Steam	
Hot Start Price						
Inter Start Price						
Cold Start Price	$4,000		$4,000			
Hourly No-Load	*****CT'S CANNOT SUBMIT NO-LOAD COSTS******					
CT Factor					*.50*	
Offer Curve (max 10 points)	MW	Price	MW	Price	MW	Price
segment 1	100	$ 55	100	$ 70	0	$0
segment 2	150	$ 80	150	$ 90	0	$0
Eco Min MW	100		100		100	
Eco Max MW	150		150		150	
Min Run Time	4 hours		4 hours		8 hours	
Use Start Up No Load	Yes		Yes		Yes	
Use Offer Slope	No		No		No	

Example 1

Example 1
1 CT + 1 ST

Combined Cost (Incremental) Curve

Data Elements	Combined Output	Production Costs	Rate Calculation	Rate
segment 1 (Min)	100 (CT1) + 50 (ST) =150	$55 * 100 MW = $5,500	$5,500/150 MW	$36.70
segment 2 (Max)	150 (CT1) + 75 (ST) = 225	$55 *100 MW = $ 5,500 $80 * 50 MW = $ 4,000 $9,500	$9,500/225 MW	$42.22

8 Hour Scheduling Rate

Data Elements	Combined Output	Calculation	Rate
segment 1 (Min)	150 MW	$\frac{8\ (\$5,500) + \$4,000}{8(150\ MW)}$	$40.00
segment 2 (Max)	225 MW	$\frac{8\ (\$9,500) + \$4,000}{8(225\ MW)}$	$44.44

Example 2

Example 2
2 CT + 1 ST

Combined Cost (Incremental) Curve

Data Elements	Combined Output	Production Costs	Rate Calculation	Rate
segment 1 (Min)	100 (CT1) + 50 (ST) =150 100 (CT2) + 50 (ST) =150 300	$55 * 100 MW = $5,500 $70 * 100 MW = $7,000	$12,500/300 MW	**$41.66**
segment 2 (Max)	150 (CT1) + 75 (ST) = 225 150 (CT 2) + 75 (ST) = 225 450	$55 * 100 MW = $ 5,500 $80 * 50 MW = $ 4,000 $9,500 $70 * 100 MW= $ 7,000 $90 * 50 MW = $ 4,500 $11,500	$21,000/450 MW	**$46.66**

8 Hour Scheduling Rate

Data Elements	Combined Output	Calculation	Rate
segment 1 (Min)	300 MW	8 ($12,500) + $8,000 8(300 MW)	**$45.00**
segment 2 (Max)	450 MW	8 ($21,000) + $8,000 8(450MW)	**$48.88**

Key Points

- Individual availability can be assigned for each component in the combined cycle group, but can affect commitment
- Having Eco Max on steam Unit set to less than the Eco Min on any CT in the CC Group will result in nothing within the CC being committed
- Suggested method to model the unit is to submit offer data on the CTs, can be offered the other way

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Next Steps

1. Open eMKT Sandbox by July 1, 2005
2. Participants notify PJM if they what units they would like to test in Sandbox PJM will model units in Sandbox first
   - Contact = Gerry McNamee (610-666-8944 or mcnamegd@pjm.com)
   - Participants may submit and revise information in Sandbox for Testing purposes
3. Final Decision Made by participant
4. Go Live in eMKT Production on August 1, 2005

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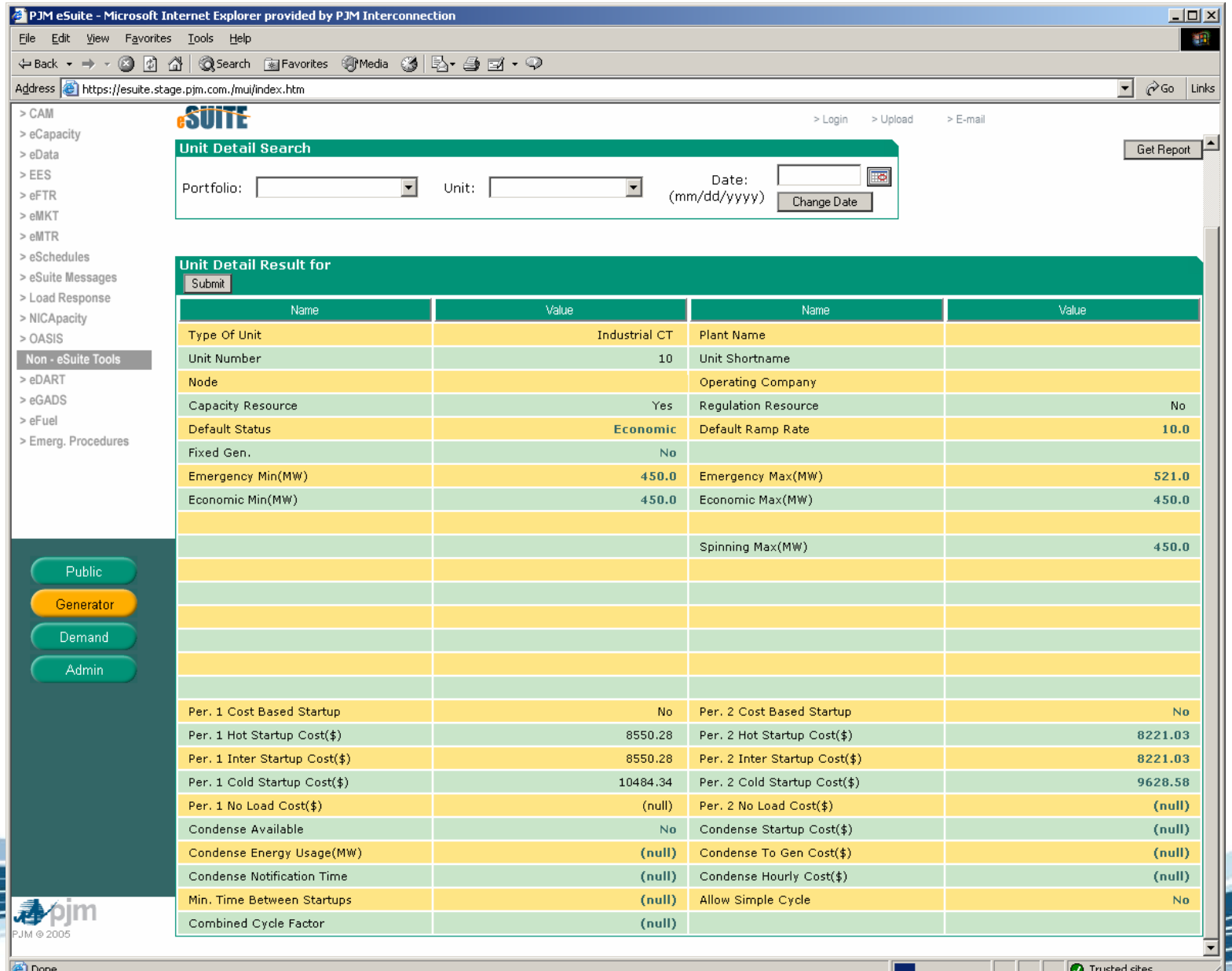
What's New?

- New Fields
  - CT Factor
  - Minimum Time Between Starts
  - Allow Simple Cycle
- Ability to view separate components

Unit Detail Screen



Name	Value	Name	Value
Type Of Unit	Industrial CT	Plant Name	
Unit Number	10	Unit Shortname	
Node		Operating Company	
Capacity Resource	Yes	Regulation Resource	No
Default Status	Economic	Default Ramp Rate	10.0
Fixed Gen.	No		
Emergency Min(MW)	450.0	Emergency Max(MW)	521.0
Economic Min(MW)	450.0	Economic Max(MW)	450.0
		Spinning Max(MW)	450.0
Per. 1 Cost Based Startup	No	Per. 2 Cost Based Startup	No
Per. 1 Hot Startup Cost($)	8550.28	Per. 2 Hot Startup Cost($)	8221.03
Per. 1 Inter Startup Cost($)	8550.28	Per. 2 Inter Startup Cost($)	8221.03
Per. 1 Cold Startup Cost($)	10484.34	Per. 2 Cold Startup Cost($)	9628.58
Per. 1 No Load Cost($)	(null)	Per. 2 No Load Cost($)	(null)
Condense Available	No	Condense Startup Cost($)	(null)
Condense Energy Usage(MW)	(null)	Condense To Gen Cost($)	(null)
Condense Notification Time	(null)	Condense Hourly Cost($)	(null)
Min. Time Between Startups	(null)	Allow Simple Cycle	No
Combined Cycle Factor	(null)		

Unit Model Changes

"Unit modeling changes in the PJM eMKT system (unit type, aggregation level, for example), not including changes based on physical changes at the plant, can be made at the beginning of each quarter."

PJM Manual 11, Section 2


Questions?